Hawaii Agricultural Experiment Station,

HONOLULU.

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A Preliminary Report on Cotton Experiments.

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The Hawaii Experiment Station has in progress investigations in the culture of cotton, of which this bulletin is a first report. Nine varieties or strains, representing three distinct classes, are under comparative test for yield, quality of lint, habits of growth and methods of culture. Considerable attention is being given to the selection of superior individual specimens, with a view to securing desirable mother plants from which to breed pure strains. It is believed that a method of propagation has been devised whereby the qualities of an individual plant may be perpetuated. Owing to the tendency of cotton to cross-fertilize, plants propagated by seed show more or less variability and any scheme which will tend to establish a uniform strain should prove a distinct aid in cotton breeding.

A systematic pruning experiment was begun as soon as the first crop was harvested, the general culture project including the test

Hawaii has exceptionally fine climatic conditions for cotton. The increasing demand for cotton in the world's markets puts upon us the duty of adding to the supply. To grow the best cotton requires careful selection of seed. This cannot be done in the nurseries without danger of hybridzation. Fortunately, the effects of crossing can be easily avoided by the propagation of selected plants through cuttings. The present bulletin contains the first published account of this method as applied to cotton. By its use the cotton breeder will be able to accomplish results without danger of the mixing of strains by cross-fertilization.—E. V. Wilcox.

TABLE I YIELD OF VARIETIES OF COTTON, 1908 EXPERIMENTS. (1)

Test No.	Variety	Seed Cotton per Picking and for Total Crop. (Average Yield per Plant and Calculated to Acre Yields).											Per Cent. Lint	Total Yield Lint per Acre	Total Yield Seed per Acre	No. of Bolls per Pound Seed-Cotton	Length of Staple	Quality
		First Picking			Second Picking			Third Picking			Total Crop							
		Date	Yield per Plant	Yield per Acre	Date	Yield per Plant	Yield per Acre	Date	Yield per Plant	Yield per Acre	Yield per Plant	Yield per Acre						
			Ounces	Pounds		Ounces	Pounds		Ounces	Pounds	Ounces	Pounds		Pounds	Pounds		Inches	
100	Sea Island (Fla.).....	Aug. 8	4.6	1006	Sept. 14	.75	164	Oct. 12	.70	152	6.0	1322	31.0	409	913	102	1½ — 1⅞	Exceptionally Good
101	Sea Island (Ga.)	Aug. 8	7.1	1561	Sept. 14	2.4	466	Oct. 12	1.12	243	10.4	2270	31.0	703	1567	102	1½ — 1⅞	Exceptionally Good
102	Upland (Chinese).....	Sept. 12	7 0	(2)	Oct. 14	4.6	.....	Nov. 5	3.75	.....	15.4	.....	34.5	.....	.....	96	⅞+	Very Fair
103	Caravonica (Wool).....	Oct. 16	3.7	805	Nov. 14	3.0	655	Nov. 25	.91	198	7.6	1658	33.0	547	1111	105	1¼ — 1½	Fair
104	Caravonica (Wool) ...	Oct. 31	3.2	(2)	Nov. 14	1.5	.....	Nov. 30	1.56	.....	6.3 (5)	.....	39.0	.....	211	98	1½ — 1¾	Exceptionally Good
105	Caravonica (Silk).....	Oct. 31	2.9	(2)	Nov. 14	1.2	.....	Nov. 30	1.11	.....	5.3 (5)	.....	33.0	.....	193	100	1½ — 1¾	Fair
106	Caravonica (Wool) ...	..... (3)	44.0	1955	Aug. 8	30.4	1292	(4)	29.60	1258	104.0	4505	37.0	1667	2838	105	⅞+	Fair
107	Caravonica (Silk).....	..... (3)	30.0	1275	Aug. 8	20.0	850	(4)	20.00	850	70.0	2975	32.0	952	2023	109	⅞+	Fair
108	Caravonica (Kidney)	..... (3)	20.0	850	Aug. 8	19.6	833	(4)	18.00	765	57.6	2448	29.0	710	1738	105	¾+	Poor

(1) Tests Nos. 100 to 105 inclusive were sown March 9-30, 1908; tests Nos. 106-108 inclusive, were two year old plants at time of first picking.
Tests Nos. 100-103 inclusive, were planted 2½ x 5 feet apart or 3484 plants per acre; tests Nos. 104-108 inclusive were planted about 10 x 10 feet apart or 680 plants per acre.

(2) Owing to the limited number of plants under test the average yield per plant only is given.

(3) Harvested during the summer previous to August 8.

(4) After August 8 and up to November 30.

(5) A fourth picking on December 20th brought the yield of Test No. 104 up to 11 5 ounces per plant, and Test No. 105 up to 8.4 ounces per plant; all the plants except two in each test, were then pruned. The unpruned plants persisted in producing a few bolls through the remaining period up to March 30, 1909.

of varieties as a perennial crop. In addition to the experiments conducted on the Station grounds, which are here reported in full, several cooperative experiments were conducted with interested parties in different parts of Oahu, the results of which are only briefly recorded. Beginning with the present year, two carefully planned experiments on a large scale were undertaken with private parties cooperatively, the Station supplying the seed, fertilizers and supervision.

That much local interest is being taken in cotton culture is attested by the application for seed and information, which has taxed the Station to the utmost. Seed has been distributed to about fifty applicants, representing many sections throughout the islands. Altogether, seed sufficient to plant about 200 acres has been distributed within the last twelve months and it is safe to say that at least 100 acres are planted to cotton at this time. While definite conclusions cannot be drawn from a single set of experiments, the present data may indicate some of the possibilities of cotton growing in Hawaii.

VARIETY TESTS.

Table I summarizes the results of the first year's comparative test of varieties. The Sea Island type of cotton is characterized by its long, strong, silky staple especially adapted to the manufacture of fine threads and mercerized goods. It brings the highest price of all cottons, ranging from 20 to 50 cents a pound, according to quality and supply. The demand is said to be constantly increasing, and while the market for the choicest grades at the highest prices is now rather limited, it does not seem likely that the amount that may be grown in Hawaii can materially affect the market.

As will be seen by referring to Table I, seed sown March 9th-30th, produced a first picking August 8th; a second, September 14th; and a third, on October 12th. The Florida strain yielded at the rate of 1322 pounds seed cotton per acre, equivalent to 409 pounds lint, or thirty-one per cent. The Georgia strain produced at the rate of 2270 pounds seed cotton, yielding 31 per cent fiber, or an equivalent of 703 pounds lint per acre. It should be noted that the first picking gave by far the largest yield, main-

ly because subsequent pickings became infested with the bollworm. The quality of the lint, the weights of which are recorded, was very choice, ranging from 1 1-2 to 2 inches in length and of good color and strength. Aside from that grown at the Station, an especially fine sample of lint was grown at Hauula from the same stock of seed. Concerning its culture the grower writes, under date of October 19, 1908, as follows: "The seeds were planted last April, on the edge of a marsh. The cotton sent you (13 1-4 pounds seed-cotton) is from about forty plants growing from six to eight inches apart and about six feet high. Much of the cotton was lost owing to the wind, and its late picking." This little test represents a very high yield, an average of five ounces per plant, from one picking, with plants set less than one foot apart. Another lot, grown at Waialee, gave similar results. A large area of land of this type is available for cotton culture.

Four different samples, submitted to D. N. Shoemaker, cotton expert, of the U. S. Department of Agriculture at Washington were rated as follows:

"Sample E*—Sea Island, (unginned), Florida Strain.
Color, white
Length, 1 1-2—1 7-8 inches
Strength, good
Drag, good
Covering of seed, good for Sea Island
Uniformity of lint, fair."

"Sample F†—Sea Island, Georgia Strain.
Color, white,
Length, 1 1-2—1 7-8 inches
Strength, good
Drag, good
Covering of seed, good
Uniformity, good."

The A. P. Brantley Company reported as follows: "We should say that sample H‡ has staple quite two inches in length, and is very strong, fine cotton. We consider sample G* to have staple 1 3-4 to 1 7-8 inches in length and is also fine and strong.

"We do not think there is any Georgia or Florida cotton in this crop to compare with this cotton. We should think that it would class more nearly with Fine or Extra Fine Islands. We notice that these two grades are quoted in Charleston, S. C., at 22 and 24 cents.

"It is quite difficult to estimate the value of this cotton, because it is in a class by itself."

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* Station Test No. 100
† Station Test No. 101.
‡ Hauula cooperative experiment.
* Waialee cooperative experiment.

Samples were likewise submitted to the cotton factors' association of Bremen, Germany, who made a most extended and favorable report, quoting 30 to 34 cents per pound for lots of sufficient quantity. Other reports have been similarly favorable and it would appear that there is an active demand for this quality of cotton at good prices. Compared with the yields, obtained in the Sea Island belt, the Station experimental yields, based on one-tenth acre plots, as well as those of smaller lots grown cooperatively, were very satisfactory. Authorities are also unanimous as to high quality of the fiber. It would appear that the samples grown on the windward side of the island directly facing the sea, have better conditions for producing the desirable qualities of length, fineness and strength of fiber.

The bolls of Sea Island cotton are small as compared with those of other types, averaging about 102 to the pound, which, together with the rather tenacious grasp in which the cotton is held, increases the cost of picking over that of other sorts. From 50 to 60 pounds of seed cotton per day was the maximum amount picked by a fairly active Japanese laborer, or, at the rate of about five cents per pound for lint. Experienced pickers could doubtlessly do much better.

At this writing (March 30, 1909), the second year's crop is well under way. Squares are forming in great profusion, and it is believed that the yield will average 50 per cent greater than that from the first year plants. After the third and final picking of the crop, in October 1908, seven months from seeding, the pruning experiment was begun in accordance with the following plan: Series I, plants cut back immediately after final picking, October 12th, prunings burned to destroy infested bolls; Series II, Plants cut back immediately following December rains; Series III, Plants cut back January 2, 1909; Series IV, Plants not pruned. Two types of pruning were adhered to under each series. In one type, the plants were cut back to within three or four inches of the ground, which is designated as type "A;" and in the other, the plants were pruned back to 12-20 inches, or equivalent to one-third to one-half their original growth, which has been designated as type "B." No laterals were permitted on the low pruned plants but spurs bearing two to four buds were maintained on the long pruned canes, if they were well located.

Most of the plants had shed the greater part of their leaves during the dry period following the last picking in October, and in consequence, remained quite dormant up to the first rains in December. However, the plants pruned immediately after harvest, especially those pruned low, were forced into fairly active growth almost immediately after being cut back. The different periods and types of pruning, together with the dry and wet seasons, are means for controlling the resting period of the plant, and within certain limits, the subsequent fruiting period and harvest of the crop. Thus, as was to be expected, drought and noninterference brought about partial dormancy, while on the other hand, pruning, irrigation and cultivation stirred the plant to renewed activity, apparently in direct ratio to the degree and sequence in which the several influencing factors were applied. The most marked results followed a combination of all the conditions named.

So far as these factors can be controlled, they will aid the grower in securing the strongest and most uniform plants; in determining the best seasons for maturity, from the standpoint of labor and prices; in the control of insect pests and diseases; and in obtaining the quality and quantity of product, which will determine success or failure.

From present indications, the best growth is secured from low pruning in January. Plants so treated are making the strongest and most uniform growth of wood, and appear to be the most prolific. Their season of ripening should prove much more favorable than that of plants pruned in October. The latter already show an occasional mature boll, as well as great irregularity in fruiting when pruned high. It should be remembered that the foregoing applies primarily, if not entirely, to the Sea Island cotton.

The qualities to be sought in Sea Island cotton are long lint (1 3-4 inch or longer), uniform staple, strength and drag of fiber, high percentage of lint, lustrous cream-white color, fineness, productiveness, well formed plants, long medium-large well filled bolls, and resistance to disease.

There is every indication that Sea Island cotton will adapt itself to culture as a perennial. The plants on the Station grounds are entering their second year in promising conditon. And

as is well known, many stray specimens in the islands are five or more years old and still flourishing. A limited amount of Station grown seed is available for distribution.

Test No. 102 deals with an upland type of cotton of Chinese origin. The seed was procured from Mr. Ah Ai, to whom it was sent from China as of exceptional quality. The fiber is said to be used entirely for mixture with wool, and it is claimed, commands a ready sale at prices equivalent to about 40 cents American currency. As will be seen by referring to Table I this cotton gave the heaviest yield per plant of all varieties tested, sixteen plants approximating an average yield of one pound seed cotton per plant, equivalent to 1150 pounds of lint cotton per acre, if planted 2 1-2 by 5 feet apart.

The plants are dwarf as compared with the Sea Island type, of broad base and pyramidal form; very compact and of uniform growth; fruiting limbs branch frequently and occur at close intervals. The plant is an extremely prolific and continuous bearer. As grown at the Station during the past year, the plants were slower in maturing than the Sea Island, the first picking being made September 12th. An average of nearly 50 mature bolls per plant presented themselves at one time.

The locks were very easily picked and showed some inclination to shed when left too long. Nearly twice as much of this cotton could be picked in a given time as of Sea Island, the bolls in addition being somewhat larger and more easily reached. The percentage of lint to seed is larger than in Sea Island, averaging 34.5 per cent, but the fiber bears no comparison in length.

Concerning samples of lint of this variety submitted to Mr. Shoemaker, who judged the Sea Island samples, we have the following report:

"Color, white
Length, 7-8 inches
Strength, good
Drag, fair
Covering of seed, fairly heavy
Uniformity of lint, good."

"It would grade as 'very fair' American Upland in length."

The Chinese are said to claim for it unusual qualities of "warmth and feel," and because of these qualities, it is termed

"fire" cotton, and should the demand and prices be satisfactory this variety may prove of special value in certain localities where Sea Island does not thrive. It seems drought resisting, and is believed to be hardy. The plant does not seem to be as well adapted to perennial culture as Sea Island, a number of the plants dying at the end of the first season. Several of the pruned plants, however, are making a fairly vigorous growth and may in time acquire the habit of persisting from year to year. The same general scheme of pruning as applied to the Sea Island cotton was adopted for this variety, but the limited number of plants available makes conclusions uncertain at this time. Samples of lint have been submitted to cotton factors in China and reports will be given to the press. A limited amount of selected seed is available for distribution.

The Caravonica cottons (tests Nos. 106-108), were grown from seed received from the originator in Queensland in 1905, by Mr. William M. Langton, who passed it on to the Station for trial. The seed was sown in July and is probably the first Caravonica cotton grown in Hawaii. Caravonica "wool," (test No. 104), and Caravonica "silk" (test No. 105), were grown from seed secured by Mr. E. W. Jordan from the originator in 1907.

The Caravonica class of cottons are of a comparatively new type, of hybrid origin, one of the parents unquestionably being the Sea Island with a probable admixture of the arborescent kidney type. The three strains designated by the originator as "wool," "silk" and "kidney" are characterized by their large, upright growth which assumes a tree form after the second year. The plant succeeds eminently as a perennial and three year old plants of the three types, grown on the Station grounds, show every indication of persisting indefinitely.

The heavy yielding power of this class of cottons is indicated in Table I, (tests Nos. 106-108). A conservative estimate of average yields from two year old plants, in a series of ten specimens, are 104, 70 and 57 ounces seed cotton per single plant, covering a period of approximately twelve months. This is equivalent to yields of 4505, 2975 and 2448 pounds of seed cotton, respectively per acre, with plants set 10 x 10 feet apart, which allows 680 plants per acre. The percentage of lint was 37, 32 and 29 per cent, respectively. The length and quality of the fiber had greatly deteriorated, but this was probably due to

the entire neglect of the plants, which had not been tilled, irrigated or pruned for over a year. The plants appear to be responding to a severe pruning and it is hoped that the original quality may be restored by careful culture.

Test No. 103, a selection from the neglected plants in test No. 106, yielded a considerably better sample of lint than was obtained from the parent plants. The yields were fair considering that the habit of this class is to fruit late. The planting was made at the same distance as the Sea Island and Upland, which overcrowded the plants, doubtless to their detriment. The percentage of lint was not so high as in the parent stock, nor does the uniformity appear as good. This may be explained as being due to cross-fertilization, the three strains being planted in close proximity.

Mr. Shoemaker submits the following report concerning samples of this variety:

"Sample B—Caravonica Wool Cotton, 1908 Crop.
Color, slightly darker brown than A
Length, 1 1-4—1 1-2 inches
Strength, very strong
Drag, good
Covering of seed, fairly heavy
Uniformity of lint, only fair
Seeds many of them of the 'Kidney' type."

"This sample lacks a great deal of being uniform, and this is the one great fault of Caravonica cotton—it is a hybrid and one of the parents is a 'Kidney' cotton; that is, the seeds are all glued together in a mass in the center of each lock. The lint in this sample varies greatly in length, and the variation in the character of the seeds would probably make considerable difficulty in ginning."

Caravonica "Wool" (test No. 104), although planted at ample distances apart, yielded lightly, averaging 6.3 ounces seed cotton per plant up to November 30th, eight months after planting. A subsequent picking in December, just preceding pruning, brought the yield per plant up to the average Sea Island. Since however, the plants require at least twice as much room as the Sea Island, and Upland types, it will be seen that the yields would be smaller. The amount of lint is high, averaging about 40 per cent. As will be seen from Mr. Shoemaker's report, which follows, the quality of the lint is considered choice.

"Sample C—Caravonica Wool Cotton, 1908 Crop.
Color, much like first sample*
Length, 1 1-4—1 3-8 inches
Strength, very strong
Drag, good
Covering of seed, heavy
Uniformity of lint, fair."

"I think this sample is hardly so uniform as sample "A"; but otherwise, not far different."

As in the case of pruning the Sea Island cotton, this test shows the same general effects, i. e., late, low pruning tends to the production of a uniform growth of canes, together with unformity in fruiting. This report would be incomplete without a brief mention of the remarkable results obtained by Mr. E. C. Smith at The Peninsula near Pearl City. In a well sheltered spot, some thirty hills were planted to the identical stock seed sown in test No. 104. The ground is of a broken coral formation intermixed with a dry silty loam. It appears to be shallow, but papaias, bananas and other garden truck thrive with but little irrigation. The elevation is about ten feet above sea-level. Sown on January 6, 1908, the plants began bearing in August, and have continued to fruit almost uninterruptedly up to the present time. Careful test weighings from the three best plants, covering the first twelve months of growth, gave the following yields in seed cotton, averaging 40 per cent lint: 36, 40 and 48 ounces respectively.

Of this cotton, Mr. Shoemaker reports as follows:

"Sample A—Caravonica Wool Cotton, 1908 Crop.
Color, light brown, much like Egyptian
Length 1 1-2—1 3-8 inches
Strength, very strong, much stronger than ordinary cotton.
Drag, very good
Covering of seed, heavy
Uniformity of lint, good."

"This is a very beautiful sample of cotton, and I believe that if you could secure a field which would uniformly produce this grade, that it would be very much more valuable than any other sample submitted; in fact, more valuable than most of the Sea Island that is produced anywhere at present."

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* See report on Caravonica cotton grown by E. C. Smith.

Samples of this cotton have been submitted to American, English, French and German cotton experts, all of whom have made favorable reports, and prices ranging from 14 to 23 cents per pound have been freely quoted. It seems certain that this variety would prove of exceptional fitness to well sheltered lowlands. An extensive area is being planted, and definite data may be looked for at the end of another year. A cooperative pruning experiment is being conducted with Mr. Smith's plants. It appears that, under his conditions, high pruning, similar to that practised by California prune-growers, will give the best results.

CULTURAL NOTES.

Soil.—The experiments herein recorded were conducted at the Station grounds on a well drained, silty loam of fair depth and moderate fertility. The cotton plant appears to thrive best in light, rather than heavy soils, although thrifty plants abound throughout the islands on all kinds of soil.

Temperature.—The Station records show the minimum temperature, covering the period of these experiments, to have been 58° F. and the maximum, 86° F. The mean minimum was 64.5° and the mean maximum, 84.3°. The average temperature for the year was 73.0°. The Station grounds are at about 70 feet elevation. No data are at hand on the limits of temperature and elevation for the cotton crop in Hawaii, but it is hoped that the numerous plantings now made will shed needed light on this phase of the work.

Moisture.—The rainfall during the period in this report, approximated 30 inches. In addition to the natural precipitation, the cotton planted in March received three irrigations, all of which preceded May 1st. This brought the total moisture up to approximately 33 inches for the year. The total moisture supplied up to the first picking was something less than 20 inches. It is believed that the cotton plant, when once established, is tolerant to a lesser amount of moisture than most of our cultivated crops, and that it may be grown over a wide range of unirrigated territory by the aid of thorough tillage calculated to husband limited amount of soil moisture. The moisture in the Station cotton plots, as determined by the Station chemist, was found to be 14.06-17.51 per cent one foot below the surface during the periods of greatest growth.

Tillage.—Insufficient tillage was accorded the cotton plots during the earlier stages of preparation. After lying in undisturbed fallow for some months, the ground cracked badly through drought. A single plowing, followed immediately by a discing and cross-discing, preceded the planting of the seed. The short interval between breaking up the land and seeding was too short to prepare a suitable seed bed and bring about a conservation of soil moisture; and a preliminary irrigation had to be made to facilitate germination. Subsequent tillage was frequent and thorough, and although the season was unusually dry, two additional irrigations were found sufficient to carry the crop to successful fruiting. Tillage has been found to be a most important factor in the culture of cotton. Deep plowing, at least on our leeward uplands, where the nature of the sub-soil permits, would seem advisable. Storage room is thus provided for the conservation of all the rainfall; the deep rooted cotton obtains a good foothold and the feeding ground for the extensive root system is greatly enlarged. Frequent shallow surface tillage lessens evaporation by providing a soil or dust mulch; keeps the soil aerated; destroys weeds and avoids the harboring of insect pests.

Planting.—The Sea Island cottons and Caravonica "Wool" cotton (103) were planted in hills two and one-half feet apart in rows five feet apart, or 3484 hills per acre. Five seeds were planted in a hill, two inches deep. All but a single strong seedling were removed when the plants were six to ten inches tall. The Sea Island seed germinated very poorly and some destruction by cut-worms necessitated considerable transplanting to make a full stand. Transplanted seedlings never attain as good growth as plants from direct sowings, although sturdy seedlings may be successfully transplanted under favorable weather conditions.

With late plantings, or in localities with minimum moisture, it is recommended to plant the Sea Island and Upland cottons in four foot rows, hills two feet apart in the row. Early plantings in more favorable locations had better be planted 2 1-2 x 5 feet apart. Especially important is this wider spacing when the crop is grown as a perennial. In this case it will be necessary to remove every alternate plant the second year, making the final stand 5 x 5 feet, or 1742 plants per acre. Our Caravonica plants stand approximately 8 x 8 feet apart. This is too close for two

year old plants under our conditions, 10 x 10 feet would be better; but for less favorable conditions, 4 x 8 feet apart for the first year, thinned out to 8 x 8 feet would give good results.

The Caravonica Nos. 104 and 105, were planted very wide apart, but would have yielded quite as well had they been planted closer. In calculating acre yields, 5 x 10 feet was used as the space factor. The results obtained with Caravonica No. 103 indicate that much closer planting would be feasible for the first year's growth, but more experience is necessary to prove this point. It has also been found that close planting acts as a protective measure against destructive winds, especially while the growth is young and brittle. The severe winds of November 28th and 29th failed to damage mature plants, while less severe winds at an earlier period badly shattered the Caravonica plants growing far apart.

To avoid the expense of hand tillage as much as possible, it is essential that planting be done in straight check rows at sufficient distances apart to facilitate horse cultivation. Planting may also be done with a horse seeder, but until seed becomes more plentiful, it will be more economical to plant by hand. The best season for planting has not yet been determined experimentally, but it is believed that as soon as the ground is in good working condition, after the first of January, and up to the first of March, cotton may be planted on the leeward side of Oahu. Planting later than March, unless the rainy season extends beyond that time, will likely result in the plants making a poor growth unless irrigation is provided. On the other hand, early planting should be avoided in excessively wet localities.

To a certain extent, the time of planting controls the harvesting period. The aim should be to have the crop mature at the most favorable season for picking, both from the standpoint of weather conditions and labor supply. During the past year the Upland cotton matured in six to seven months; the Sea Island in about the same length of time; and the Caravonica, from one to two months later.

Fertilization and Rotation.—The cotton plant is a strong feeder and it seems very likely that our most fertile soils may within a few years of cotton growing, respond profitably to a rational system of fertilization. A fertilizer experiment was attempted in connection with the Sea Island cotton during the past year,

and while some benefit appears to have resulted from the application of 300 pounds per acre of a complete fertilizer; based upon the removal of an average crop of cotton, the unusual dry weather made the outcome too uncertain to form definite conclusions. We now have in progress a fertilizer experiment covering two acres.

That the rotation of other crops with cotton will prove beneficial, there can be no doubt. Experiments along this line are well under way; but it will require several years before definite data can be secured. Corn, soy beans, peanuts and other leguminous crops would enter well into a two or three-course rotation. In the southern United States corn and cow peas most frequently enter into rotation with cotton, although in the Sea Islands themselves, rotation is too often neglected.

Picking and Ginning.—Picking will probably prove the heaviest item of expense and one of the most difficult problems the Hawaiian cotton grower will have to meet, until the industry becomes adjusted. Tests made on a small scale at the Station indicate that a good Japanese laborer can not pick over fifty pounds of average Sea Island cotton per day of ten hours; possibly a fourth more of Caravonica; and at best, a hundred pounds of Upland, which is the easiest of all to pick. Greater skill would doubtlessly be acquired with experience. Even by piece work, the cost at present would probably run from $1.00 to $2.00 per 100 pounds seed-cotton, depending on the variety and yield.

The removal of the lint from the smooth seeded cottons, such as the Sea Island and Caravonica types, is done on the roller-gin to avoid injury to the long and more delicate staple. The more closely adhering and coarser Upland lint is removed on saw-gins, which also have greater capacity. Small machines of both types, are on the market; but a large central ginning plant would prove more economical when the area under cotton warranted its establishment. For experimental purposes, the Station uses a simple wooden contrivance of Japanese manufacture, which is well suited for the removal of seed from selected plants. Its cost is about $5.00. By replacing the rubber rollers on a wash-wringer, with wooden ones, a simple roller-gin of twenty or thirty pounds daily capacity could easily be made.

Seed Selection.—To the writer's mind the most important single factor in the future success of the cotton industry in Ha-

waii will be the development and maintenance of superior strains of the type of cotton which proves best suited to a given locality. Grade and quantity of lint are the chief qualities sought for in cotton, although the value of seed may in time prove equally important. These qualities are very largely hereditary, and as the plant is extremely variable, the opportunities for selection are correspondingly great.

The striking difference between individuals among a given lot of plants are well illustrated in our experiments with the Sea Island cottons. In row 4, of the Florida strain, the plants ranged from 24 to 60 inches in height; adjoining plants bore 30 to 120 bolls, and yielded four to 18 ounces of seed-cotton. The percentage and length of lint were somewhat more uniform, but differences in these respects were sufficiently marked to allow of considerable improvement by selection. Other qualities, such as early and late maturing, length of fruiting period, ease of picking, inclination to shatter, resistance to pests and diseases, all may be controlled to a large extent by careful selection. Some sixty selections of individual plants have been made during the past year from among the Station plants. These will be planted separately and selection made, generation after generation, a definite ideal being kept in mind. It will be well for growers to start out with the best seed obtainable, and then select rigidly their best plants for stock seed.

The seed from each mother plant should be sown separately and the progeny again carefully examined for breeding plants showing improvement. A single plant will yield 500 or more seeds the first year, and the progeny from this stock should produce sufficient seed to plant from ten to twenty acres the year following.

In the search for a method whereby the qualities of an individual specimen might be perpetuated, a scheme of propagation by layers or cuttings was hit upon. It was noted that the old Caravonica plants budded freely from the surface roots and as many as ten plants were secured from a single lateral by this method. This suggested that similar results might be secured from cuttings of the branches and a large number were made from immature wood. These gave indifferent results and a more systematic experiment was undertaken as the plants ma-

tured and were ready for general pruning. Accordingly, on December 15th, cuttings were made from a number of select plants, representing the three classes of cotton under experiment. Selecting the best formed and most fruitful branches, cuttings were made from the tip end, the intermediate portion and the base. Cuttings eight to ten inches long and containing five to eight eyes, were cut from each of the three divisions and planted in the field after the manner of rooting grape cuttings. The Sea Island and Caravonica cottons rooted equally well, about fifty per cent of all the cuttings planted rooting and making a satisfactory growth. The Caravonica root cuttings practically all grew, and are making a fine growth. The Upland cuttings failed entirely. With the Sea Island, the base cuttings rooted best, but with the Caravonicas, the tip cuttings gave the largest percentage of strong plants. With the Caravonica root cuttings, all portions were of about equal value. At this writing one hundred days from planting, the cuttings have grown from twelve to thirty inches in height. Squares are forming on some of the advanced plants, and the general growth compares favorably with stock grown from seed. It is believed that a larger percentage of cuttings can be made to grow under more favorable conditions.

Mr. E. C. Smith of Pearl City has demonstrated that it is feasible to propagate the Caravonica cottons by budding, and this method would likewise lend itself to furthering the work in hand.

The plan now is to grow any desired number of cotton varieties and strains in comparative tests and as individual plants are selected for breeding purposes they are marked. When the proper time for pruning arrives all available wood is utilized for cuttings. These are then planted in isolated plots and allowed to fruit. The resultant seed will be of a pure strain.

Should continuous inbreeding tend to the deterioration of a strain, some method of line-breeding, as successfully practiced by breeders of other crops, can doubtlessly be devised, the "ear-row" plan for the improvement of cotton being suggested as a feasible method. The important point is that we now have a simple method whereby the exceptional individual when once found may be propagated true to type.